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AUTHOR Sandman, Richard S.
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ABSTRACT

This study indicates that eighth graders have higher mathematics anxiety than eleventh graders, and boys have higher mathematics anxiety than girls. Eighth-grade classes with high mathematics anxiety tend to have high motivation in mathematics, but tend to see mathematics as not very useful in society. Both grade levels show a positive relationship between class mathematics anxiety and both friction and favoritism in the classroom, and a negative relationship between class mathematics anxiety and both class mathematics achievement and the perceived difficulty of the class. (MP)

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Factors Related to Mathematics Anxiety in the Secondary School

Richard S. Sandman

University of Minnesota

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Factors Related to Mathematics Anxiety in the Secondary School*

Richard S. Sandman

University of Minnesota

This paper reports on the results of a study investigating the relationship between certain variables and mathematics anxiety in the secondary school. The data were collected as part of a large-scale evaluation project supported by the National Science Foundation (Welch and Gullickson, 1973). Data were gathered from 413 representatively-selected mathematics classrooms from throughout the states of California and Indiana. Approximately half were eighth-grade classrooms, and the other half were eleventh-grade classrooms. Approximately half were measured in 1972, the other half in 1976.

Data on mathematics anxiety were obtained using the Mathematics Attitude Inventory (MAI) (Sandman, 1974, 1978, 1979). This instrument consists of 48 statements about mathematics, to each of which the student either strongly agrees, agrees, disagrees, or strongly disagrees. The 48 items are divided into six scales intended to measure the following six constructs of mathematics attitude:

Anxiety toward Mathematics: The uneasiness a student feels in situations involving mathematics.

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Perception of the Mathematics Teacher: A student's view regarding the teaching characteristics of his or her mathematics teacher.

Value of Mathematics in Society: A student's view regarding the usefulness of mathematical knowledge.

Self-Concept in Mathematics: A student's perception of his or her own competence in mathematics.

Enjoyment of Mathematics: The pleasure a student derives from engaging in mathematical activities.

Motivation in Mathematics: A student's desire to do work in mathematics beyond the class requirements.

The MAI was administered to a random half of the students in each of the 413 mathematics classes mentioned above. A total of 5034 students were measured. A factor analysis of the item scores from all these students yielded six factors. These could easily be identified with the six constructs that the instrument was designed to measure, and thus support was provided for the construct validity of the instrument.

Students were scored on each of the six factors through a regression procedure employing the scores on all 48 items (Rummel, 1970, pp. 437-441). Scores on the Anxiety factor were standardized with a mean of 50 and a standard deviation of 8.5, with high scores representing high anxiety toward mathematics. The six items with highest loadings on the Anxiety factor are given in Table 1. These items contributed most strongly to the Anxiety factor scores and thus can be considered indicative of the construct these scores represent.

Table 1

Items with High Loadings on the Anxiety Factor of the MAI

I feel tense when someone talks to me about mathematics.

Working with numbers upsets me.

It makes me nervous to even think about doing mathematics.

I would rather be given the right answer to a mathematics problem than to work it out myself.

It scares me to have to take mathematics.

If I don't see how to work a mathematics problem right away, I never get it.

For each of the other five factors, a high score denotes a favorable attitude toward mathematics.

Students filling out the MAI were also administered the Learning Environment Inventory (LEI) (Anderson, 1970). This 70-item Likert-type instrument is designed to measure a student's perception of the social and emotional climate of learning within the classroom. Ten scales assess ten different aspects of the classroom learning environment:

Diversity: The extent to which the class provides for a diversity of student interests and activities.

Formality: The extent to which behavior within the class is guided by formal rules.

Friction: The extent to which conflict exists among the students in the class.

Goal Direction: The extent to which the goals of the class are recognized by its members.

Favoritism: The extent to which differential treatment of students exists in the classroom.

Difficulty: The extent to which the work of the class is perceived as difficult.

Democratic: The extent to which all students participate in class decisions.

Cliqueness: The extent to which cliques are present in the classroom.

Satisfaction: The extent to which students are satisfied with the class.

Disorganization: The extent to which the class is

perceived as disorganized.

While half the students in the class were completing the MAI and LEI, the other half were taking a 40-item multiple-choice Mathematics Achievement Test (MAT). Two forms of this test were available, one suitable for eighth graders and the other for eleventh graders.

First, a five-way analysis of variance was performed on the MAI Anxiety factor scores. The five independent variables were year (1972 and 1976), region (California and Indiana), grade level (8 and 11), sex of student (boys and girls), and sex of teacher (men and women). Due to the failure of some students and teachers to indicate their sex, only 4612 of the 5034 students were included in the analysis. Correcting for unequal cell frequencies, the estimated mean of these 4612 students on the Anxiety factor scores was 49.7.

The results for the five main effects are shown in Table 2. For each factor the means of the two levels are given along with the significance of the difference between them. Only differences at the .01 level or better were taken to be significant. Thus Table 2 shows that the year, region, and sex of teacher main effects are not significant, but that eighth graders have higher mathematics anxiety than eleventh graders, and boys have higher mathematics anxiety than girls. The last result is contrary to the usual observation that girls suffer more from mathematics anxiety than do boys.

The only significant interaction, and that at the .01 level, was a three-way interaction involving year, sex of

Table 2

Results of Anova on MAI Anxiety Factor Scores--Main Effects

Factor	First Level	Mean	Second Level	Mean	Significance of Difference
Year	1972	49.6	1976	49.8	NS
Region	California	49.8	Indiana	49.5	NS
Grade Level	Eighth	51.4	Eleventh	48.0	.0001
Sex of Student	Boys	50.4	Girls	49.0	.0001
Sex of Teacher	Men	50.0	Women	49.3	NS

student, and sex of teacher. In 1972 girls were more math anxious with men teachers than with women teachers, while for the boys the teacher's sex made no difference. In 1976 boys with men teachers were more math anxious than those with women teachers, while the teacher's sex made no difference for the girls.

The next task was to determine how the Anxiety factor scores related to factor scores on the other five constructs of mathematics attitude. It made no sense to do this for individual scores since the six factors were orthogonal by derivation. However, class means on the six factor scores could meaningfully be interrelated. The class means were calculated for each of the 413 classes, and the Anxiety factor score means were correlated with the mean scores on each of the other five factors. The analyses were performed separately for eighth- and eleventh-grade classrooms. Results are given in Table 3. The highest correlations show that eighth-grade classes with high mathematics anxiety tend to place a low value on mathematics in society, but tend to be high in motivation toward mathematics, an unexpected result. Other eighth-grade relationships, and all eleventh-grade relationships, are considerably weaker.

Relating mathematics anxiety to mathematics achievement also required the use of class means, for different halves of the class took the attitude and achievement measures. Thus the mean MAI Anxiety factor score for one half of the class was correlated with the mean MAT score for the other half of

Table 3

Correlation of MAI Anxiety Factor Scores with Scores on the Other Five MAI Factors (Class Means)

Factor	Eighth Grade (n = 184)	Eleventh Grade (n = 229)
Teacher	-.04	-.04
Value	-.32***	.06
Self-Concept	.04	-.17**
Enjoyment	-.18*	-.19**
Motivation	.30***	.11

*$p < .05$

**$p < .01$

***$p < .001$

the class. For the eighth grade, with 184 classrooms, this correlation turned out to be -.47 ($p<.001$). When the analysis was restricted to 1972 classes or 1976 classes, or to classes with men teachers or classes with women teachers, this correlation was very consistent, varying only between -.46 and -.50. Thus in the eighth grade there is a strong tendency for classes high in mathematics anxiety to be low in mathematics achievement. The strength of this relationship seems even more remarkable considering it was derived using different halves of the classes.

For the eleventh grade, with 227 classrooms, the overall correlation was -.17 ($p<.01$). While this weak negative correlation was consistent over the two different years and with classes having men teachers, classes with women teachers, of which there were only 41, showed a weak positive correlation between the two variables.

Finally, it was desired to relate MAI Anxiety scores to scores on the LEI. Since the LEI assesses the student's perception of the classroom learning environment, it made sense to use class means here as an overall indication of what that environment is. Accordingly, class means on the MAI Anxiety factor scores were correlated with class means on each of the ten scales of the LEI. Here the mean scores on the two instruments could be derived from the same students. Again, separate analyses were carried out for eighth- and eleventh-grade classrooms. The overall correlations are given in Table 4. These show, for both grade levels, a positive

relationship between class mathematics anxiety and both friction and favoritism in the classroom, and a negative relationship between class mathematics anxiety and the perceived difficulty of the class, this last being a surprising finding. These relationships are stronger for the eighth-grade classes than for the eleventh-grade classes. Additional analyses show that within each grade level the correlations are consistent over both years and both teacher sexes, with the exception that eleventh-grade classes with women teachers fail to exhibit any relationships between Anxiety and either Favoritism or Difficulty.

Summary

The findings of this study can be summarized as follows: Eighth graders have higher mathematics anxiety than eleventh graders, and boys have higher mathematics anxiety than girls. Eighth-grade classes with high mathematics anxiety tend to have high motivation in mathematics but tend to see mathematics as not very useful in society. Both grade levels show a positive relationship between class mathematics anxiety and both friction and favoritism in the classroom, and a negative relationship between class mathematics anxiety and both class mathematics achievement and the perceived difficulty of the class; however, these relationships are stronger for eighth-grade classes than for eleventh-grade classes.

Much speculation can be generated concerning the mechanisms acting to produce any one of these relationships. While such

Table 4

Correlation of MAI Anxiety Factor Scores with Scores on the Ten Scales of the LEI (Class Means)

Scale	Eighth Grade (n = 184)	Eleventh Grade (n = 229)
Diversity	-.04	.10
Formaltiy	.07	-.04
Friction	.29***	.22***
Goal Direction	-.16*	-.08
Favoritism	.30***	.18**
Difficulty	-.38***	-.20**
Democratic	-.13	-.08
Cliqueness	.10	.12
Satisfaction	-.09	[illegible]6
Disorganization	.22**	.12

*p < .05

**p < .01

***p < .001

speculation will not be engaged in here, readers are encouraged to develop and test their own cause-and-effect hypotheses with a view toward achieving better understanding and control of mathematics anxiety in the secondary classroom.

References

Anderson, G. J. The Learning Environment Inventory manual. Centre for Learning and Development, McGill University, 1970.

Rummel, R. J. Applied factor analysis. Evanston, Ill.: Northwestern University Press, 1970.

Sandman, R. S. The development, validation, and application of a multidimensional mathematics attitude instrument (Doctoral dissertation, University of Minnesota, 1973). Dissertation Abstracts International, 1974, 34, 7054A-7055A. (University Microfilms No. 74-10,626).

Sandman, R. S. The Mathematics Attitude Inventory: Construction and validation. Unpublished manuscript, University of Minnesota, 1978.

Sandman, R. S. Mathematics Attitude Inventory user's manual. Minnesota Research and Evaluation Center, University of Minnesota, 1979.

Welch, W. W., & Gullickson, A. R. A strategy for evaluating the NSF Comprehensive Program for Teacher Education. School Science and Mathematics, 1973, 73, 759-767.